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TACTICAL AND STRATEGIC RESPONSIVENESS IN A COMPETITIVE RISK-TAKING GAME

AD-A181 059

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WHIPP 28   APRIL 1987

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DEPARTMENT OF PSYCHOLOGY ■ UNIVERSITY OF WISCONSIN ■ MADISON, WISCONSIN 53706

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER WHIPP 28	**2. GOVT ACCESSION NO.** AD-A181059	**3. RECIPIENT'S CATALOG NUMBER**
4. TITLE (and Subtitle) Tactical and Strategic Responsiveness in a Competitive Risk-taking Game		**5. TYPE OF REPORT & PERIOD COVERED** Technical Report
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Lola L. Lopes and Jeff T. Casey		**8. CONTRACT OR GRANT NUMBER(s)** N00014-84-K-0065
9. PERFORMING ORGANIZATION NAME AND ADDRESS The Board of Regents of the University of Wisconsin System 750 University Ave., Madison, WI 53706		**10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS** R & T: 4425079
11. CONTROLLING OFFICE NAME AND ADDRESS Office of Naval Research 800 North Quincy Arlington, VA 22217		**12. REPORT DATE** April 1987
		13. NUMBER OF PAGES 57
14. MONITORING AGENCY NAME & ADDRESS(If different from Controlling Office)		**15. SECURITY CLASS. (of this report)** Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

risk attitude, competition
aspiration level, tactical responsiveness, game playing
strategic responsiveness, security motivation, potential motivation

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Two within-subject experiments are reported in which subjects played either the offensive or the defensive role of a computerized board game. In either role, the subject's task for each move was to choose between alternative outcome distributions. The game was designed so that subjects were generally best off on offense if they chose the riskier of the two distributions and best off on defense if they chose the more conservative of the two distributions.

The results of the experiments are analyzed with respect to subjects' actual

preferences (risk averse vs. risk seeking) and to their ability to mesh preferences with task requirements. In general, all subjects shifted toward risk seeking when they were in poor game position. However, there was no general tendency for subjects to be more risk seeking on offense than on defense. Moreover, there was no general tendency for the best subjects on offense to be also best on defense. Instead, it appears that subjects' responses to the game were mainly local (i.e., tactical) and did not involve global (i.e., strategic) shifts in risk preference.

Although behavior under risk and behavior under competition are linked historically and theoretically by von Neumann and Morgenstern's monumental <u>Theory</u> <u>of</u> <u>Games</u> (1947), the two subject matters have rarely touched one another empirically. This dissociation reflects, in large part, differences in the dominant research paradigms for the two domains. Studies of risky choice typically focus on the pattern of subjects' preferences for various kinds of gambles or lotteries. For reasons of experimental control and analytical tractability, such studies typically rely on static tasks that maintain trial to trial independence. In most cases, the preferences that subjects express are only hypothetical, but even when some of the preferred options are to be played, such play is almost always postponed until the end of the experiment so that vagaries of good or bad luck will not contaminate the results. Studies of competition, on the other hand, usually involve dynamic tasks in which two or more subjects produce sequences of mutually contingent choices between simple alternatives. In these tasks, the focus is on the patterns of cooperation or competition that evolve over the course of the game and on the effects that these patterns have on the final outcomes to the players.

In this paper, we report the results of two exploratory studies of people's risk preferences in a dynamic, competitive game in which subjects were offered substantial payoffs for good performance. Our analysis focuses on the degree to which people's preferences depend on the general requirements of the task (i.e., whether they are

playing an offensive or defensive role) and on the specific circumstances in which they find themselves (i.e., whether they are in good or poor game position).

THE GAME

The game is played by two players on a 32 by 32 grid of squares. The lower 13 rows of the grid constitute the winning area for defense and the upper 13 rows constitute the winning area for offense. The middle 6 rows are a "no man's land" in which neither offense nor defense wins, i.e., the game is a standoff.

Each game is made up of a series of nine <u>exchanges</u> consisting of an offensive move in which squares are taken by the offensive player followed by a defensive move in which squares are re-taken by the defensive player. The goal of the offense is for the game to end with a net of 609 or more squares taken (i.e., more than 19 rows). The goal of the defense is for the game to end with a net of 416 or fewer squares taken (i.e., 13 or fewer rows).

Insert Figure 1 about here

As with many board games, the number of squares to be taken or re-taken on a single move is determined by a random device. But instead of always using the same spinner or die, the players in this game are offered their choice of two different outcome distributions

on each move. Figure 1 shows the different offensive distributions and Figure 2 shows the different defensive distributions. Each distribution shows the possible numbers of squares that might be taken (or re-taken) on the next move, indicated by the numbers at the left of each row, and the associated probability of that particular outcome, indicated by the number of tally marks (relative to 100 tally marks in all for each distribution) to the right of each row. Beneath each lottery is a single letter code and a descriptive name. The codes were used to identify the distributions to subjects. For mnemonic ease, however, we will refer to the lotteries by their descriptive names.

Insert Figure 2 about here

The offensive distributions each have an expected value of roughly 100 squares and the defensive distributions each have an expected value of roughly 50 squares. Thus, the long-run value of a game is about 9 x 100 squares taken by offense minus 9 x 50 squares re-taken by defense = 450 squares overall[1]. Although this particular value is a standoff, the game is not perfectly balanced since 450 lies only about one fifth of the way into the no man's land, making it easier objectively to win on defense than on offense. Simulations of offensive and defensive play (with an n of 5,000 sessions of 10 games each) indicated that when both players are choosing randomly, the offensive player should win about 22% of the games, the defensive

player should win about 41% of the games, and the remaining 37% of the games should be standoffs.

The elements that we introduce into the game in order to achieve increased realism (e.g., sequentiality, randomness, feedback, payoffs, limited trials, etc.) render existing normative models intractable and irrelevant. However, rather than being a deterrant to the exploration of dynamic tasks, we see this as reinforcing the need for a behavioral/psychological theory of dynamic decision making, i.e., a theory of how people cope and, for the most part, succeed in the face of complexity.

SECURITY, POTENTIAL, AND ASPIRATION

Our theoretical approach will be based on a new theory of risk taking in which choices among risks are assumed to reflect an option's attractiveness on the factors of security, potential, and aspiration (Lopes, 1984, in press; Schneider & Lopes, 1986). The security of an option reflects an assessment process in which the weight that is applied to an outcome in the set of possible outcomes increases monotonically according to how bad the outcome is. Thus, for the lotteries shown in Figures 1 and 2, the security assessment process would weight the smaller outcomes (shown at the bottom of each lottery) more heavily than the larger outcomes.

The security assessment process has great theoretical interest. As has been argued elsewhere (Lopes, 1984, in press) this pattern of

weighting plays a theoretically isomorphic role to marginally decreasing utility in terms of accounting for risk aversion. People who are primarily motivated to achieve security make choices that are classically risk averse. However, the security assessment concept is more powerful descriptively in accounting for the rationales that people give for their choices. Moreover, as Yaari (in press) and Jaffray (1987) have argued, such a process can also be defended as normative.

The potential assessment process is essentially opposite to security assessment. In potential assessment, the best outcomes in an option are weighted more heavily than the worst outcomes. Thus, people who are primarily motivated to achieve potential will make choices that are similar to those predicted by a marginally increasing utility function. Since security motivation and potential motivation are essentially opposite to one another, they would ordinarily not exist in the same person at equal strength. Thus, security and potential motivation represent a dimension on which a particular individual has a value that is, in most cases, displaced toward one or the other of the two goals.

One's position on the security/potential dimension is assumed to reflect a dispositional variable, something that describes an individual's typical response to risk. However, people also respond to the immediate requirements of the situations in which they find themselves. Thus, risk averse people (i.e., those motivated by security) sometimes take chances, and risk seeking people (i.e.,

those motivated by potential) sometimes play it safe.

The aspiration assessment process is a <u>situational</u> variable that reflects the degree to which an option is likely to meet the immediate needs of the individual. The process operates by increasing the weight on the outcomes in an option that are at or above the current aspiration level. Thus, a security motivated person would ordinarily avoid options like the long shots in Figures 1 and 2. However, if the situation demands a very high outcome, these options would become relatively more attractive than safer options such as the short shots because they are more likely to yield the necessary high outcomes.

EXPERIMENTAL OBJECTIVES

The present experiments had three primary objectives: (a) determining the extent to which subjects change their preferences strategically according to the demands of the role being played; (b) determining the extent to which subjects change their preferences tactically according to the demands of the current game position; and (c) determining the extent to which such changes in subjects' preferences (if they occur) lead to improved performance.

Strategic Responsiveness

The game was designed so that the offensive and defensive roles would, on the face of it, conform to the conventional norm that offensive behavior calls for aggressiveness and risk acceptance whereas defensive behavior calls for conservativeness and risk avoidance. When playing on offense, the subject begins each game in the worst position possible (i.e., no squares taken) and has only nine moves to achieve his or her goal. In addition, achieving that goal requires that he or she average 35% above the expected net number of squares per exchange (67.67 vs. 50). In general, these circumstances call for an aggressive style of play in which the subject should ordinarily choose the risker option in each pair.

In contrast, a subject playing on defense begins each game in the best position possible (i.e., no squares lost) and need only hold this position for nine moves. Given the advantage to the defense in expected value, the defensive player need only average 3.77% below the expected net number of squares per exchange (46.22 vs. 50) in order to win. Thus, he or she should typically play conservatively, choosing the safer option in each pair.

We examine strategic responsiveness in the present experiments by comparing subjects' preferences under the two role manipulations. Since subjects were limited to a few games (15 in Experiment 1 and 10 in Experiment 2), there was little opportunity for learning. Thus, we think of strategic responsiveness as being analytical in nature, occurring primarily in response to the structure of the situation.

Obviously, however, given proper sorts of feedback and time to experiment, we would expect that any subject could learn to play either role appropriately.

Tactical Responsiveness

Because the game was made short (i.e., nine exchanges), there was wide variability in final game positions across the different games. We wanted this variability because we wanted to find out how subjects respond to short-term predicaments. In order to do this, game positions were classified into good, neutral, or poor depending on the board position (numbers of squares taken) and the number of exchanges remaining in the game. Preferences for the various distributions were then examined separately for each of the three positions.

The algorithm for classifying board positions was based on the net number of squares the subject was averaging per exchange toward his or her goal[2]. An average $\geq$ 67 was good position for offense and poor position for defense since that rate, if continued, would yield a win for the offense. An average of $\leq$ 46 squares was good position for defense and poor position for offense since that rate, if continued, would yield a win for defense. Averages between 46 and 67 were considered neutral position for both offense and defense since that rate, if continued, would yield a standoff.

Our interest in board position concerned whether subjects would shift their preferences according to game position. In particular, we wanted to see whether there would be a general shift toward preference for the riskier options when the subject was in poor game position regardless of whether the subject was playing offense or defense.

Winners and Losers

Although our primary experimental questions concerned patterns of preference under the two roles and in various game positions, we were also interested in whether subjects differ in the skill with which they play the game. Conceivably, *four different situations might exist:* (a) All subjects might play the game equally poorly. In this case preference patterns should be either random or inappropriate to the role, and winning and losing should be determined pretty much by chance. (b) All subjects might play equally well. In this case preference patterns should be appropriately related to role but, because subjects are equally skilled, winning and losing should be determined primarily by chance. (c) Some subjects might be able to win at greater than chance levels on either offense or defense, but not on both. This would occur if subjects have preferred patterns of choice that favor one or the other role but have difficulty shifting preferences when required to do so by the other role. (d) Some subjects might be better than

other subjects in <u>both</u> roles, being able to win at greater than
chance levels on both offense and defense. This would require that
subjects be able to shift preferences strategically for the two
roles.

Our task was designed to give us reasonably reliable estimates
of subjects' preference patterns for a number of different
distributions and a number of different game positions. However, the
number of games played in either role was small and the influence of
chance factors on outcome was large since one or two exceptional
draws often determined a particular game's winner. Consequently, we
were not able to use the actual number of games won by subjects as a
measure of skill. Instead, we used the dynamic data to abstract the
pattern (i.e., the rank order) of each subject's play in each of the
two roles and used these to simulate the proportion of games that
would be won or lost in the long run by a subject playing that
strategy. The simulation procedures are described more completely in
what follows.

<div align="center">EXPERIMENT 1</div>

<div align="center"><u>Method</u></div>

Experiment 1 was conducted in two sessions held on different
days. For the first session, subjects were randomly assigned to
either the offensive or the defensive role of the board game

described previously. An Apple II+ computer took the opposing role.
Roles were then reversed for the second session. During the first
part of each session, subjects played 15 complete games with the
computer. Then they were given a "probe" task in which they
indicated how they would respond to various game-board
configurations.

Display

The game board (see Figure 3) was displayed on the computer
screen. Arrows at the left of the 13th and the 20th rows marked the
top of the defensive winning area and the bottom of the offensive
winning area, respectively. The number of the current exchange was
indicated to the right of the game board. Squares on the board that
belonged to the defense were empty and squares that belonged to the
offense were filled. At the beginning of each game, all the squares
were empty. As squares were taken by the offense they were filled in
an S-shaped pattern running from the lower left to the upper left.
As squares were re-taken by defense they were emptied in the inverse
order.

Insert Figure 3 about here

The 10 possible distributions for the subject were displayed on
a 2' by 3' poster along with single letter codes (see Figure 1 for
offense and Figure 2 for defense). On each exchange, the CRT
displayed the letter codes of the two distributions between which the

subject was to choose. Subjects responded by typing the letter of the chosen distribution on the keyboard.

For the sake of simplicity, the computer always drew from a single distribution. This was the appropriate rectangular distribution (i.e., Distribution I of Figure 1 when the computer was on offense and Distribution I of Figure 2 when the computer was on defense). It was displayed for the subject's information on a separate card.

Design

For the dynamic task (i.e., the game), the various distributions for each role were combined into their 45 possible pairs (10 distributions for each role taken 2 at a time). Three replications of these pairs were then ordered randomly subject only to the constraints that (a) all pairs in a given replication occur before any pairs of later replications and (b) no given distribution appear in two successive pairs. The 135-pair series thus created was then blocked into 15 games of 9 exchanges each. Three separate such series were created for each role and one third of the subjects were randomly assigned to each.

For the probe task, a representative subset of six distributions (J, B, D, I, A, and F) for each role was combined into its 15 possible pairs and each of these pairs was then combined factorially with a good, neutral, and poor game position. For each role, these game positions were created by varying the number of squares taken and the exchange number. For both roles, the neutral position was

early in the game (Exchange #3) and an average number of squares had been taken. The good and poor positions were near the end of the game (Exchange #7) and either a relatively large or a relatively small number of squares had been taken. (Information about exact positions is given in Table 1.)

Insert Table 1 about here

Each of the 45 probe-task stimuli (15 pairs x 3 board positions) for each role was printed on a plain sheet of white paper with the board position displayed at the top and the two distributions displayed side by side at the bottom. Pages were ordered randomly in a three-ring binder.

Procedure

At the beginning of the first session, subjects were seated in front of the computer terminal. The screen showed an empty game board at the first exchange and listed by letter the two distributions between which the subject would choose on his or her first move. Subjects were told that we were interested in their opinions about distributions of uncertain outcomes. Then we outlined the rudiments of the game and explained how to interpret the distributions. For ease of communication, we referred to the distributions as "lotteries" and called the tally marks "tickets." Tickets were considered to be numbered consecutively beginning with 1 at the bottom (i.e., the worst outcome) and ending with 100 at the

top (i.e., the best outcome).

We used the first exchange to illustrate the mechanics of the game, allowing the subject to make the necessary choices at each step. The exchange sequence for offense ran as follows: (a) The pair of available distributions was identified at the top of the screen by letter (see, e.g., left panel of Figure 3) and the subject typed his or her response on the keyboard. (b) The computer asked the subject how many cycles of the random number generator to run (from 1 to 9) before drawing the subject's ticket. The subject responded by typing a number and the computer then displayed that many randomly drawn ticket numbers. The last ticket number in the sequence belonged to the subject. This was immediately translated by the computer into its worth in squares and that value was displayed for the subject to read. At the same time, the appropriate number of squares were taken (i.e., filled) on the board (see, e.g., right panel of Figure 3). (c) When the subject was ready to go on, he or she pushed the space bar. This caused a ticket to be drawn from the (rectangular) defensive distribution. Its ticket number and value were displayed on the screen and, at the same time, that number of squares were re-taken (i.e., emptied) on the board. (4) When the subject was ready to go on, he or she pushed the space bar. If the game was over (i.e., 9 exchanges were complete), the computer indicated whether offense or defense had won or whether the game was a standoff. If the game was not complete, the distributions for the next move were identified and the exchange cycle was repeated.

When the subject was on defense, the exchange cycle was essentially identical except that the subject initiated the drawing of the ticket from the offensive (rectangular) distribution and learned its value before being presented with his or her choice of defensive distributions.

In order to motivate subjects to perform well, monetary bonuses were offered contingent on performance. Subjects were informed that it was harder to win on offense than on defense and that they would be rewarded accordingly at the end of the experiment. On offense, subjects were to be paid $2 each time they won, but $1 would be subtracted from their winnings each time the defense won. On defense, subjects were to be paid $1 each time they won, but $2 would be subtracted from their winnings each time the offense won.

After 15 games had been played, subjects were given the probe task notebook and were asked to indicate for each of the combinations of distribution pair and game position what their choice would be if that game position and pair were to appear in a real game. Choices were indicated by marking either "left" or "right" on a numbered response sheet.

Subjects

Subjects were 18 students at the University of Wisconsin taking an introductory psychology course. They served for extra credit to be applied to their grades. Nine subjects won positive bonuses ranging from $1 to $11. Two others earned exactly $0. The remaining seven subjects had net losses ranging from -$1 to -$10 but these

amounts were not actually collected from subjects.

Results and Discussion

In the analyses that follow, we focus on subjects' relative preferences for different outcome distributions during the dynamic task. Our attention is restricted primarily to choices from good and poor board positions since choices from neutral positions were highly variable: some subjects treated them like good positions, others like poor positions.

Dynamic preferences were measured two ways. The base data are, for each role (offense versus defense) and for each class of board position (good versus poor), the proportion of occasions on which a subject chose each distribution out of the total number of occasions on which the distribution was offered. Within each role, each of the 10 possible distributions was offered on 27 different occasions (i.e., paired with each of the other 9 distributions three times). However, the particular board positions in which distributions occurred depended on the subjects' previous choices and previous draws. Consequently, dynamic choice proportions are based on differing numbers of choices both between and within subjects.

The second measure of preference is an index of risk style that was calculated for each subject for each combination of role and board position. This is the correlation between the subject's dynamic choice proportions and the rank position of the various

distributions on _security_. (Recall that the distributions in Figures
1 and 2 are listed in order of their security level.) Positive
values of the index are indicative of security seeking or risk
aversion. Negative values are indicative of potential seeking or
risk seeking, although they differ somewhat from what would be
obtained from an index figured directly on potential. (See the
previous discussion of _security_ and _potential_.)

Choice proportions are also available from the factorially
balanced probe task that was run at the end of each dynamic session.
These data are considered only in passing since their sole purpose
was to serve as a check on the dynamic preference data.

Finally, we computed a Monte Carlo measure of the long-run
effectiveness of each subject's strategy in each of the two roles.
Because performance was strongly related to strategy, we begin by
discussing the simulation results.

Performance

In the dynamic task, subjects played 15 games in each of the two
roles. For subjects playing on offense, the actual number of wins
ranged from 0 to 7 and the actual number of losses (i.e., wins for
the computer) ranged from 3 to 10. For subjects playing on defense,
the actual number of wins ranged from 3 to 11 and the actual number
of losses from 1 to 6. Overall payoff values (considering both wins
and losses) ranged from -$8 to $11 on offense and -$8 to $9 on
defense. (Recall that since loss penalties were to be subtracted from

winnings, no subject was required to pay net losses out of pocket.)

For the most part, these actual outcomes are meaningless as data since they reflect highly variable quantities (i.e., board position at the end of only nine exchanges) averaged over a relatively few games. The problem is particularly acute for players with risk seeking preferences since winning outcomes often reflect a single lucky draw (e.g., getting one of the best outcomes in either of the two long-shot distributions). Our solution was to bootstrap from the individual preference data (135 choices per subject per role) to estimates of long-run outcomes using a Monte Carlo procedure.

Abstracting individual strategies. Subjects' choices within each role were first categorized according to whether they occurred in good, neutral, or poor board position according to the algorithm described previously. (On offense, the relative proportions of choices in good, neutral, and poor positions were .255, .347, and .398, averaged over subjects. The respective proportions on defense were .426, .255, and .319.) Then individual choice proportions were computed for each of the three board positions by dividing the number of times each distribution was chosen by the number of times it was offered. The subject's strategy (i.e., preference pattern at each of the three board positions) was then determined by converting the choice proportions to ranks.

Obviously, there were differences both between and within subjects in the actual number of choices that went into the computation of the various choice proportions. However, of the 1080

choice proportions that were computed for individual subjects (18 subjects x 2 roles x 3 board positions x 10 distributions), more than half were figured on a base of nine or more offerings, and 95% were figured on a base of four or more offerings. There were only two cases in which a distribution failed to appear in a particular board position (one on offense and one on defense). The group mean was used as an estimate in these cases.

Long-run simulations. Individual subjects' strategies on offense and on defense were input to separate Monte Carlo simulations of 1,000 experimental sessions (15,000 games) each. In these simulations, the simulated subject "chose" on each exchange between pairs of distributions in accord with the real subject's preference order for that pair at that particular board position. If two or more distributions were equally preferred by the subject (i.e., equal in choice proportion and hence tied in rank), the choice among them was made at random. Just as in the real task, the opponent always drew from the rectangular distribution.

The results are in Table 2 listed in order of hypothetical payoff values (column 4 for offense and column 8 for defense) for the 15,000 games. Columns 2 and 3 give the proportions of wins and losses on offense; columns 6 and 7 give the respective proportions for defense. Mean proportions are given at the bottom of the table along with baseline proportions obtained from 5,000 simulated sessions (75,000 games) in which choices were made at random.

The obvious difference in long-run payoff values for offense and

defense reflects two factors. The first is that having the opponent draw from the rectangular distribution was advantageous to subjects on offense and disadvantageous to subjects on defense. This is because the rectangular distribution is relatively risky, which is bad on defense and good on offense. The second factor is that the payoffs of $\pm\$2$ for offense and ±1 for defense overcompensated monetarily for the additional difficulty of the game on offense. In the real task, however, this assymmetry in final payoffs was not apparent to subjects due to the small number of games and the large variability in outcome.

Insert Table 2 about here

The main result of interest is the relatively wide range of final payoffs and of winning and losing proportions, particularly for offensive wins. Most subjects performed either well above or well below the level that would be expected by chance (i.e., by choosing between distributions randomly). On offense, subjects with the best final payoffs tended to have both greater proportions of wins and greater proportions of losses than subjects with the worst final payoffs, $r = .584$, $p < .01.$. This pattern reflects the necessity in the present task of taking risks (and, hence, accepting the increased chances of losing individual games) if one is to win on offense in the long run.

On defense, there was a mild but statistically nonsignificant

tendency in the opposite direction, r = -.261, ns. Subjects with the
best final payoffs tended to have greater proportions of wins but
smaller proportions of losses than subjects with the worst final
payoffs. This pattern reflects the general wisdom in the present
task of avoiding risks on defense unless there is an immediate
threat.

It is also obvious that there is little relationship between
subjects' performances on offense and defense: the overall
correlation between simulated offensive payoff and simulated
defensive payoff is quite small, r = -.03, ns.

Tactical and Strategic Responsiveness

Group data. Table 3 gives the mean values of the security index
for good and poor board positions in each of the two roles. The
difference between responses at good and poor positions reflects
tactical responsiveness, the degree to which subjects modulate their
choices according to the needs of the immediate moment. This
difference is large and significant overall, $F(1,17)$ = 18.45, p <
.01, indicating strong average tactical responsiveness in both
offensive and defensive roles.

The difference between responses in offensive and defensive
roles reflects strategic responsiveness. If subjects understand the
strategic difference between these two roles, then their security
indices should be more positive (i.e., more risk averse) for defense
than for offense. As is obvious, however, the means are in the wrong
direction, although not significantly so, $F(1,17)$ < 1.00. There was

also no interaction between board position and role ($F(1,17) < 1.00$).

Finally, the grand mean of the data was also non-significant, $F(1,17) < 1.00$, suggesting that over these combinations of board position and role, there was no reliable tendency for subjects to be either risk averse or risk seeking.

Insert Table 3 about here

Winners and losers. Although the group data revealed no evidence of strategic responsiveness, inspection of individual data suggested that there were clear differences among the subjects on this variable. In order to examine the relationship between outcome and responsiveness, we divided subjects into two groups on the basis of their simulated payoff values. In the analyses that follow, we call the nine subjects above the median within each role "winners" and the nine below the median "losers."

Figure 4 shows the means of the security indices for these subject groups plotted as a function of board position and role. On offense, the winners are quite responsive tactically to differences in board position, $F(1,8) = 6.85$, $p < .05$, whereas offensive losers are not, $F(1,8) = 2.39$, ns. Moreover, offensive winners are significantly more risk seeking than offensive losers, $F(1,16) = 10.68$, $p < .01$. On defense, the winners are also tactically responsive, $F(1,8) = 12.37$, $p < .01$, whereas the defensive losers are not, $F(1,8) < 1.00$. The defensive winners are also significantly

more risk averse than the defensive losers, $F(1,16) = 10.56$, $p < .01$.

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Insert Figure 4 about here

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The data in Figure 4 suggest that winners in both roles differ from losers in the degree to which they are tactically responsive. However, the figure does not show whether they are also strategically responsive because the winners and losers in the two roles are not the same groups of people. Figure 5 gives the same data plotted in a 2x2 arrangement. The left column gives the winners on defense and the right column gives the losers on defense. The top row gives the winners on offense and the bottom row gives the losers on offense. There were four subjects who were winners in both conditions and four subjects who were losers in both conditions. The remaining ten subjects were split evenly between the two winner/loser categories.

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Insert Figure 5 about here

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Obviously, there are too few subjects in each group to make statistical analysis meaningful. Nevertheless, the patterns of the data make sense. The four double winners are clearly responsive both tactically and strategically: they are relatively more risk seeking in poor position than in good position and when playing offense than when playing defense. In contrast, those who win on offense but lose on defense seem to be uniformly risk seeking in both board positions

and in both roles.

Both groups of offensive losers display some degree of tactical responsiveness, although it is stronger for the subjects who win on defense than for those who lose in both roles. Most interesting, however, is the strong _negative_ strategic responsiveness. These subjects are relatively risk averse for offense but risk seeking for defense.

A possible cause for this inversion of preferences lies in the payoff structure of the task. For subjects playing on offense, a win pays $2 whereas a loss subtracts $1. For subjects playing on defense, a win pays only $1 whereas a loss subtracts $2. If these subjects focus more on preventing losses than on achieving wins, they might play relatively conservatively on offense (taking only small chances in order to achieve at least a standoff and avoid the $1 loss) but pulling out all stops on defense in order to achieve a clear win and avoid even the possibility of the larger $2 loss.

In summary, the data suggest that overall performance in the task reflects at least four factors: tactical responsiveness, strategic responsiveness, characteristic risk style, and immediate goal. Relatively few subjects seem to display strategic responsiveness whereas most display tactical responsiveness. Some subjects' responses seem to be determined primarily by a generalized preference for certain kinds of risks. In the present case, these subjects appear to be characteristically risk seeking, which is fortunate for them on offense but unfortunate on defense. Other

subjects appear to be driven primarily by local goals that may conflict seriously with the strategic requirements of the game. Thus, subjects who focus too strongly on avoiding losses may not only fail to achieve wins, but may also suffer more losses than subjects who are less motivated to avoid losses.

Pattern of Distributional Preferences

The security index gives only a rough measure of risk preferences. In order to get a clearer picture of subjects' strategies, it is useful to look at the choice proportions for individual distributions. These are given in Figure 6 (offense) and Figure 7 (defense) for the dynamic task with separate curves for winners and losers. Distributions are listed from left to right in order of their security level. The data are the average proportions of occasions on which individual subjects chose each of the distributions in good position (left panels) and in poor position (right panels). Averages have been figured on individual choice proportions (i.e., each subjects' proportions were weighted equally regardless of the number of choices on which the proportion was based). However, the pattern of the raw group proportions is very similar. The probe task data also had the same general pattern and will not be discussed further.

_____

Insert Figure 6 about here

_____

Recall that the analysis of individual security indices showed that offensive winners were relatively more risk seeking than offensive losers and that offensive winners were responsive tactically whereas offensive losers were not. In Figure 6, the first of these results is reflected by the fact that the curves for winners in both panels lie below the curves for losers at the left end (high security) and above the curves for losers at the right end (low security). The second result is reflected in the fact that the two curves for losers are very similar in the two panels whereas the curve for winners shifts downward at the left (less preference for high security distributions) and upward at the right (more preference for low security distributions) at poor board position.

More dramatic, however, is the general U-shaped pattern of each of the four curves. This pattern is characteristic of subjects who are dispositionally high in risk seeking (Schneider & Lopes, 1986) and it is also characteristic of dispositionally risk averse subjects operating under high aspiration conditions (Lopes & Schneider, 198[7]). In both cases, the source of the U-shape is increased preference for distributions that are attractive in potential. These include the two long-shot distributions which have very high potential, but they also include the riskless distributions and the very peaked distribution which, in addition to being higher on security than the short shots, are also higher on potential since they have higher maximum outcomes. This shift toward potential is reasonable for subjects who are trying to achieve high values. Thus, even though

the offensive losers are relatively more security minded than the offensive winners, the preference patterns for both groups suggest that both winners and losers are responsive to the strategic requirements of the offensive role.

The data for the defensive role are in Figure 7. In this role, the losers are relatively more risk seeking than the winners (both curves tend to be lower at the left and higher at the right than the curves for the winners) and, again, the losers are relatively unresponsive to board position (the curves at good and poor position are very similar for losers). The losers also show the U-shaped pattern that suggests the operation of high aspiration levels. The winners, on the other hand, have preferences that are essentially determined by security level at good board position (i.e., the preferences decrease essentially monotonically left to right), whereas at poor board position the winners' preferences shift toward potential.

Insert Figure 7 about here

EXPERIMENT 2

The primary purpose of Experiment 2 was to explore the more complex situation in which real subjects take both the offensive and defensive roles of the board game. A second purpose derived from the finding in Experiment 1 that subjects who lost on offense (i.e.,

presumably relatively risk averse individuals) were more risk seeking on defense than on offense. We suggested that this inversion of the anticipated pattern might reflect a stronger desire on the part of these subjects to avoid losses than to achieve wins. In Experiment 2 we tested this explanation by looking at subjects' behavior in situations for which losses are not penalized.

Method

Experiment 2 was conducted in a single session that lasted about two hours. Two subjects were used in each session. At the beginning of the session, one subject was randomly assigned to the offensive role of the game described previously and the other to the defensive role. Halfway through the session, subjects were given a brief break after which roles were reversed. The probe task was given to subjects twice, once in the middle of the session and again (for reversed roles) at the end of the session.

During each half session, subjects played 10 complete games against their opponent. Because both subjects had to make choices, individual games took longer to play. In order to gain the benefit of increased speed, the experiment was shifted to a Macintosh 512K computer. Otherwise, the game procedures and the game board were identical to those for Experiment 1.

The offensive and defensive stimulus distributions were the same as the subject distributions used in Experiment 1. In each role,

each subject saw all possible pairs of distributions twice. The pairs of distributions were identified by letter code and were presented to subjects in notebook form. Each notebook page contained one pair, with offensive and defensive pairs presented on alternate pages. The computer display also indicated the codes of the available distributions. Subjects responded by typing the code letter of their preferred distribution.

The monetary payoffs were $3 for a win on offense (with no penalty for losses) and $1 for a win on defense (with no penalty for losses). Forty subjects (20 pairs) participated in the experiment.

Results and Discussion

Performance

In Experiment 2, subjects played 10 games in each of the two roles. For subjects playing on offense, the number of wins ranged from 0 to 6. For subjects playing on defense, the number of wins ranged from 1 to 8. Net payoffs, considering both offense and defense, ranged from $5 to $20 with a mean of $11.45.

Just as in Experiment 1, subjects' preference patterns were abstracted from their choices at good, neutral, and poor game positions for each of the two roles and simulations were run using these abstracted strategies to determine long-run performance in the two roles. In these simulations, subjects remained paired as they had been in the experiment (i.e., if Subject 1 and Subject 2 were

opponents in the experiment, their strategies were also opponents in the simulations).

As with Experiment 1, there were large differences between subjects in the proportion of games won within each of the two conditions. On offense, the proportion of wins ranged from .16 to .31 and on defense, from .37 to .46. Although the individual simulations were based on fewer data (i.e., only ten games per subject per role and only two replications per choice pair per role), the results appeared to be stable enough to allow differential analysis according to long-run outcome. Therefore, subjects were again divided into winners and losers by a median split within each role.

As was the case previously, there was no strong relationship between offensive and defensive winners. The correlation between proportion of wins on offense and proportion of wins on defense was negative, r = -.17, but non-significant, $t(1,38)$ = 1.06, ns.

Tactical and Strategic Responsiveness

Table 4 gives the mean values of the security index for good and poor board positions in each of the two roles averaged over subjects. As was the case for Experiment 1, there is a large and significant effect of board position (i.e., tactical responsiveness), $F(1,39)$ = 29.52, $p < .01$, no significant effect of role (i.e., strategic responsiveness), $F(1,39)$ = 2.25, ns., no interaction between position and role, $F(1,39) < 1$, and no effect for the grand mean, $F < 1$. In

Experiment 2, however, the mean values for offensive and defensive roles are as they should be, with greater risk seeking on offense than on defense.

Insert Table 4 about here

Figure 8 shows the data for offensive and defensive roles with subjects separated into winners and losers. On offense, both winners and losers are responsive tactically, $F(1,19)$ = 8.94 and 6.98, ps < .01 and .05, respectively, and offensive winners are significantly more risk seeking than offensive losers, $F(1,38)$ = 26.75, p < .01. On defense, winners and losers are also both responsive tactically, $F(1,19)$ = 11.93 and 7.08, ps < .01 and .05, respectively, and winners are slightly more risk averse than losers, although not significantly so, $F(1,38)$ = 1.12, ns.

Insert Figure 8 about here

Figure 9 gives the 2x2 breakdown. The pattern for subjects whose simulations won on both offense and defense (8 subjects) is qualitatively very similar to that from Experiment 1. The only real difference is that the present subjects are more risk seeking overall. This is entirely consistent with the fact that there was no penalty for losing.

The subjects whose simulations won on offense but lost on

defense (12 subjects) are similar to those of the double winners, but they are a little less responsive to board position on offense. The main difference for these subjects between Experiment 1 and Experiment 2 is that the present subjects are more risk averse on defense than on offense. This suggests that the strong defensive risk seeking displayed by the analogous subjects in Experiment 1 occurred, at least in part, because those subjects were trying to avoid the penalty for losing.

Insert Figure 9 about here

For subjects who lost on offense and won on defense (12 subjects), the pattern is different than it was in Experiment 1. The present subjects appear to be generally risk averse, which is appropriate on defense (and tends to give them a win), but inappropriate on offense. This result is also consistent with the hypothesis that the risk seeking that was displayed by analogous subjects in Experiment 1 was caused by a focus on avoiding losses.

Finally, the subjects who lost on both offense and defense (8 subjects), continue to display a pattern of greater risk aversion on offense than on defense, at least when they are in poor position. Since there is no financial difference between a standoff and a loss, they cannot be trying to guard their financial standing. However, it may be that the competitive nature of Experiment 2 engendered its own reward structure for some subjects, so that they were motivated not

only to win for themselves, but also to prevent a win for the opponent.

Pattern of Distributional Preferences

The distributional preference data for Experiment 2 are in Figure 10 for offense and Figure 11 for defense. The data are means computed on equally weighted individual choice proportions, although raw proportions had a very similar pattern. The probe data were also very similar for defense and for offensive losers, but the preferences of the offensive winners were more risk averse on the probe task than on the dynamic task.

Insert Figure 10 about here

As can be seen in the figures, the choice proportions for Experiment 2 are noisier than those for Experiment 1 and the differences between winners and losers are smaller. This reflects two factors. The first is the impact of reduced numbers of observations per subject on the simulations that were used to define winners and losers. Of the 2400 choice proportions that were estimated for individual subjects in the present experiment, the median number of observations per proportion fell from nine to six and roughly 25 percent of the estimates were computed on four or fewer observations. Equally important, however, is the fact that the simulated results for a given subject reflect not only his or her strategies, but also the strategies of the opponent with whom the

subject was paired. Thus, some strong subjects may have been classed as losers primarily because they were paired with an even stronger opponent and some weak subjects may have been classed as winners primarily because they were paired with an even weaker opponent.

Insert Figure 11 about here

Despite these difficulties, however, one can still see similarities between these data and those for Experiment 1. In particular, the winners on offense have generally riskier preferences than the losers, especially when they are in good position. On defense, the winners appear to be essentially risk averse when they are in good position whereas the losers are somewhat more risk seeking. In poor position, however, the two groups are virtually indistinguishable.

GENERAL DISCUSSION

Theoretical treatments of risky choice are typically couched in terms of psychophysical mechanisms such as nonlinear utility and probability weighting functions that distort perceptions of the "true" value of uncertain options. Even when aspiration levels are invoked, as they are in prospect theory (Kahneman & Tversky, 1979) and in some theories of constrained optimization (Masson, 1974), their influence on choice is mediated by (presumably psychophysical)

changes in the shape of the utility function. Our view is different. We believe that risky choice reflects people's attempts to achieve various goals, including general goals such as seeking security and/or potential and specific goals such as achieving particular targets (i.e., achieving the current aspiration level). Although the present studies have only scratched the surface of what might be done experimentally, they provide important glimpses of people's strengths and weaknesses in adapting to task demands in risky environments.

In our experiments, we focused on the ability of subjects to adapt to the short-run (tactical) and long-run (strategic) demands of a competitive game involving risky choices. In both experiments and in both roles, most subjects displayed tactical responsiveness (i.e., a shift to riskier choices when they were in poor game position). This behavior is consistent with previous results showing that subjects shift to riskier choices when they are losing in gambling games (Leopard, 1978; Morgan, 1983). The degree of responsiveness varied, however, between winners and losers and between payoff conditions. In Experiment 1, winners in both roles tended to be more responsive than losers whereas winners and losers were equally responsive in Experiment 2. This difference probably reflects the fact that there were penalties for losing in Experiment 1 but not in Experiment 2, making the necessity for tactical response less in Experiment 2.

The results concerning strategic responsiveness (i.e., choosing riskier options on offense than on defense) were less uniform. In

Experiment 1, only a few subjects seemed to be sensitive to the long-run role demands of the game. Not surprisingly, these subjects tended to be double winners (i.e., their strategies performed above the median on both offense and defense). The other subjects were either insensitive to role demands or were negatively responsive (i.e., they were very risk averse on offense and relatively risk seeking on defense, particularly when they were in poor position).

In Experiment 2, both groups of offensive winners displayed strategic responsiveness. Only the offensive losers were unresponsive or negatively responsive. The increased frequency of strategic responsiveness in Experiment 2 appears to reflect the elimination of penalties for losing, particularly the large penalty for losing on defense. However, the residual failures of responsiveness in Experiment 2 suggest that other factors may be at work as well. Clearly, many subjects seem not to appreciate the strategic fact that, in the present task, the best strategy is an aggressive offense coupled with a conservative defense.

In terms of the pattern of preferences for the various distributions, the results of both experiments are compatible with the hypothesis that subjects' choices reflect distributional security and/or potential. In the offensive condition of Experiment 1, the data for both winners and losers in both board positions displayed an overall U-shape with the most preferred distributions being the long shots (which are very high on potential) and the riskless distributions (which have moderate potential plus excellent

security). Distributions such as the short shots which have moderate security but very poor potential were less well liked, particularly by winners. In Experiment 2, on the other hand, winners liked the riskless distributions less well and losers liked the long shots less well than their counterparts in Experiment 1. In other words, in Experiment 2, winners were apparently more purely motivated by potential and losers were apparently more purely motivated by security. This difference is reasonable given that Experiment 1 rewarded success but also punished failure (making both security and potential important) whereas Experiment 2 only rewarded success.

In the defensive condition, the differences between the two experiments were less clear cut. In Experiment 1, winners appeared to be motivated by security in good position and by both security and potential in poor position whereas losers appeared to be motivated by both security and potential in both positions. In Experiment 2, on the other hand, winners and losers behaved similarly, being apparently motivated by security in good position but showing some concern for potential in poor position. The reasons for this greater similarily in Experiment 2 are not clear, but it may reflect the increased noise introduced into the analysis by having real subjects play both roles in the game.

In general, then, the data from the two experiments suggest real differences among subjects in their ability to respond appropriately to the strategic and, in some cases, even the tactical requirements of games involving risk. In many cases, subjects who performed

poorly displayed a pattern of "too little, too late" in terms of their willingness to take necessary risks. An unanswered but potentially important question concerning this failure concerns the degree to which people's dispositional preferences interact with role demands in producing task-relevant behavior. Previous research (Schneider & Lopes, 1987) in a different task suggests that subjects who are dispositionally very risk averse are unlikely to produce risk-seeking choices even when the situation seems to demand it. Whether this is due to a failure of nerve or to an insufficient analysis of the situation remains to be seen. In any case, it would be interesting to know whether subjects who are responsive both strategically and tactically differ from those who are not in terms of their initial attitudes toward risk. Future studies will investigate this point.

A second unanswered question concerns the factors that mediate strategic responsiveness in those subjects who are, in fact, responsive. Three possibilities exist. (a) Responsiveness in the present task may be mediated by the conventional norms for offensive and defensive behavior (i.e., norms that orient subjects toward aggressive play on offense and toward conservative play on defense). (b) Responsiveness may reflect subjects' accurate assessments of the contingencies in the game as suggested by the initial game states (i.e., offense in worst possible position and defense in best possible position) and/or by the instructional information that it is harder to win on offense than on defense. (c) Responsiveness may

reflect the direct effect of the payoff manipulation (i.e., greater payoffs on offense than on defense). Obviously, in our task (and in many naturally occurring competitive situations), these factors all point the same way. We should, however, be able to get a clearer picture of the relative impact of the factors in future studies by manipulating them independently.

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Footnotes

1. The expected value for defense was actually a little less than 50 because on some occasions the defensive player was unable to take full advantage of his or her draw. For example, if on Exchange 1, the offensive player drew a ticket worth zero squares, the defensive player's move (unless it was also zero) would be wasted since there were no squares to be re-taken.

2. The computation for the defensive player was complicated by the fact that the defensive decision is made at a time when the offense has had N plays and the defense has had only N-1 plays. In order to extrapolate fairly from the current position, a whole number of exchanges has to be considered. Thus, the extrapolation for the defensive player was based on the current position plus 50 squares since this is the expected position that the player will be in after his or her move.

Table 1

Board Positions for Probe Task

Role	Level	Ex. #	Sq. Taken	Row/Col.	
Offense	Neutral	3	100	3	4
	Good	7	533	5	31
	Poor	7	191	16	21
Defense	Neutral	3	200	6	8
	Good	7	329	10	9
	Poor	7	596	18	20

Note. Ex. = exchange. Sq. = squares.

Table 2

Results of 1000 Simulated Sessions

for Individual Subjects in Offensive and Defensive Roles

	Offense				Defense		
S#	Wins	Losses	Payoff	S#	Wins	Losses	Payoff
6	.2567*	.4221	1,367	11	.4207*	.2245*	-424
7	.2596*	.4305	1,331	4	.4147*	.2255*	-544
9	.2505*	.4332	1,318	18	.4154*	.2263*	-557
3	.2465*	.4218	1,069	14	.4093	.2246*	-598
12	.2523*	.4338#	1,063	5	.4051	.2251*	-675
8	.2481*	.4338#	936	17	.4131*	.2311	-737
4	.2290#	.3995*	877	9	.3967	.2270*	-859
5	.2361	.4273	675	3	.3989	.2283	-864
14	.2261#	.4097*	638	15	.4196*	.2391	-878
17	.2379	.4394#	547	13	.3977	.2289	-901
15	.2322	.4338#	459	1	.4026	.2323	-929
1	.2351	.4511	286	12	.3935#	.2287	-958
2	.2234	.4400	102	8	.3972	.2352	-1,098
11	.2065#	.4063*	101	2	.4033	.2385	-1,106
13	.2089#	.4141*	55	7	.3994	.2407	-1,229
10	.2029#	.4130*	-107	6	.4073	.2469#	-1,296
18	.1775#	.4063*	-769	16	.3963	.2426#	-1,334
16	.1764#	.4101*	-859	10	.3979	.2459#	-1,409
Mean	.2281	.4237			.4049	.2328	
Random	.2386	.4258			.4018	.2346	

Note. Payoffs on offense equal $2 per win minus $1 per loss. Payoffs on defense equal $1 per win minus $2 per loss.

* = Subject's simulated value better (i.e., more wins or fewer losses) than random strategy at p < .05.

= Subject's simulated value worse (i.e., fewer wins or more losses) than random strategy at p < .05.

Table 3

Average Value of Security Index

for Experiment 1

	Offense	Defense	Mean
Good Position	.171	.146	.159
Poor Position	-.091	-.090	-.091
Mean	.040	.028	.034

Note. Positive values of the index signify security seeking (risk aversion).

Table 4

Average Value of Security Index

for Experiment 2

	Offense	Defense	Mean
Good Position	.100	.214	.157
Poor Position	-.226	-.112	-.169
Mean	-.063	.051	-.006

Note. Positive values of the index signify security seeking (risk aversion).
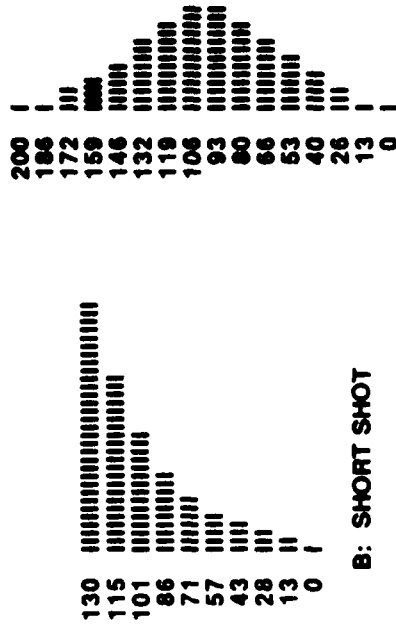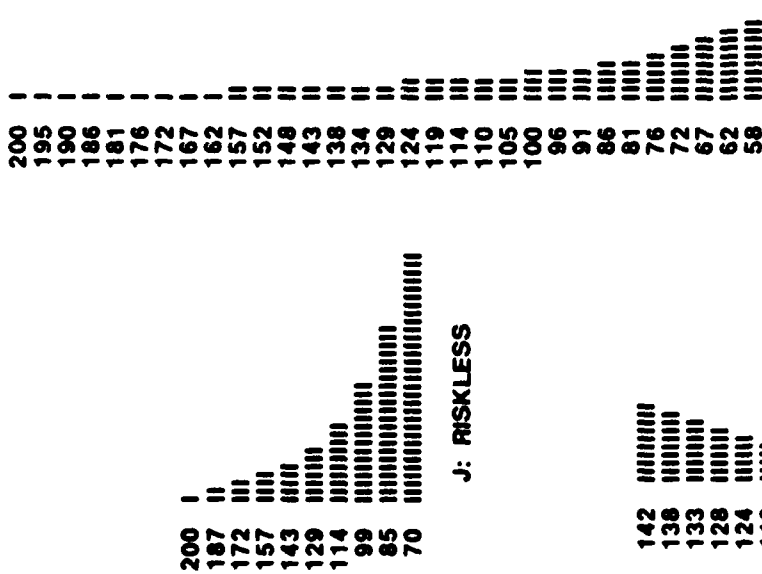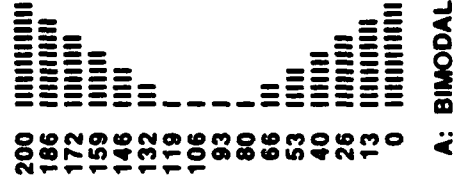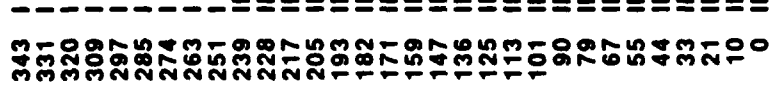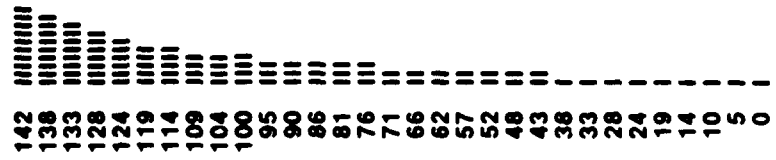
Figure 1: Offensive Distributions
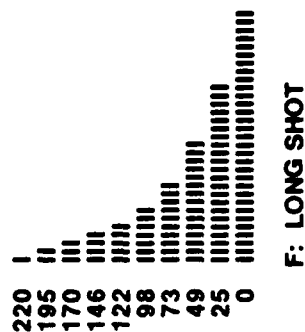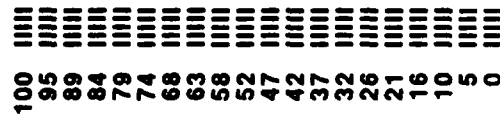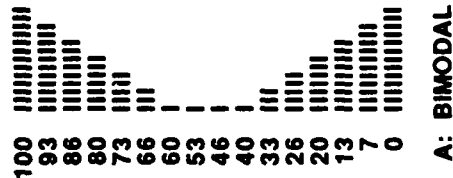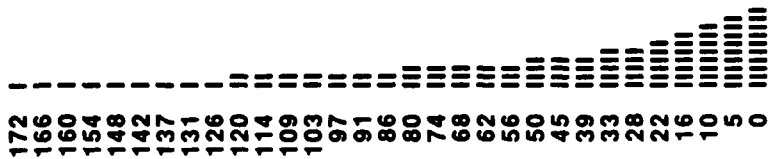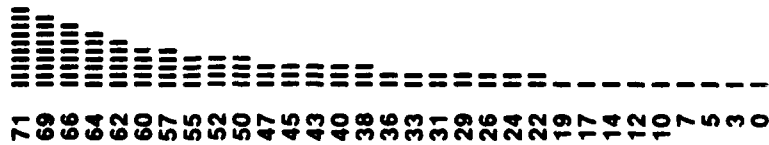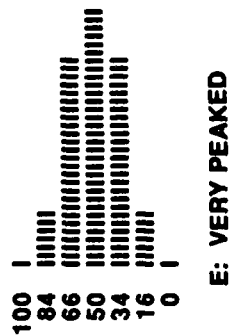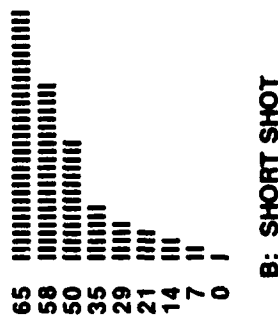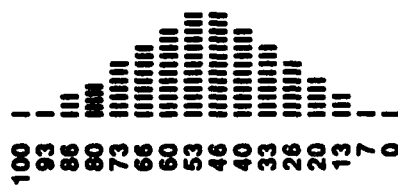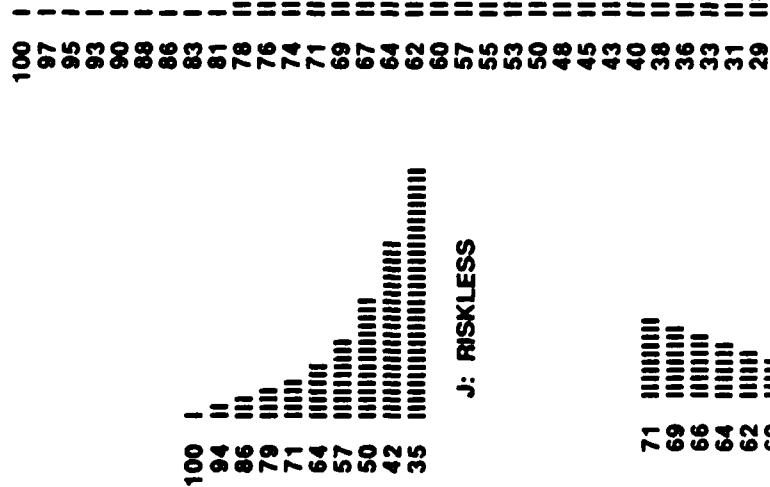
Figure 2: Defensive Distributions
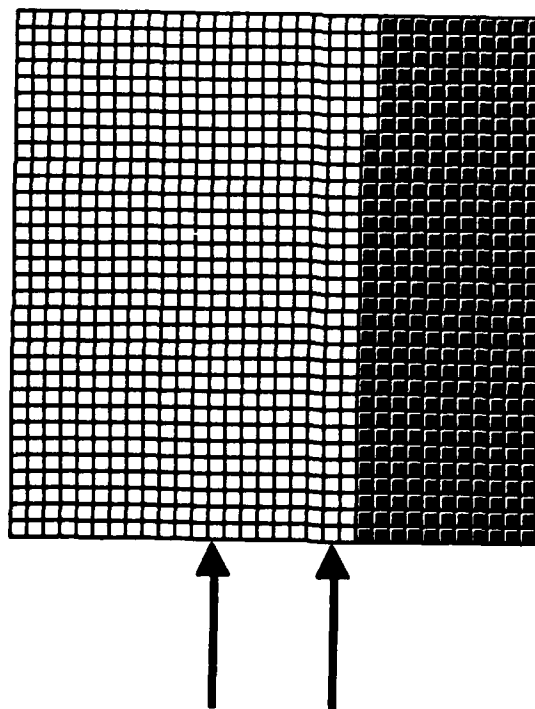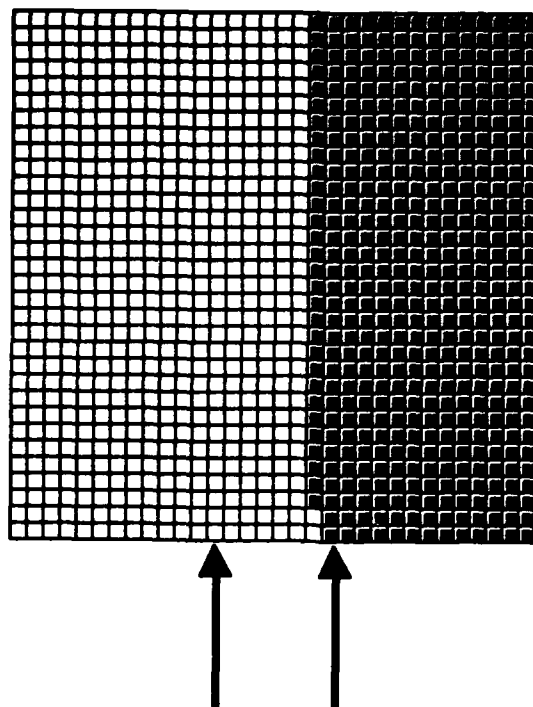
Figure 3: Game screen at two stages of play.

OFFENSE   DEFENSE

RISK STYLE INDEX
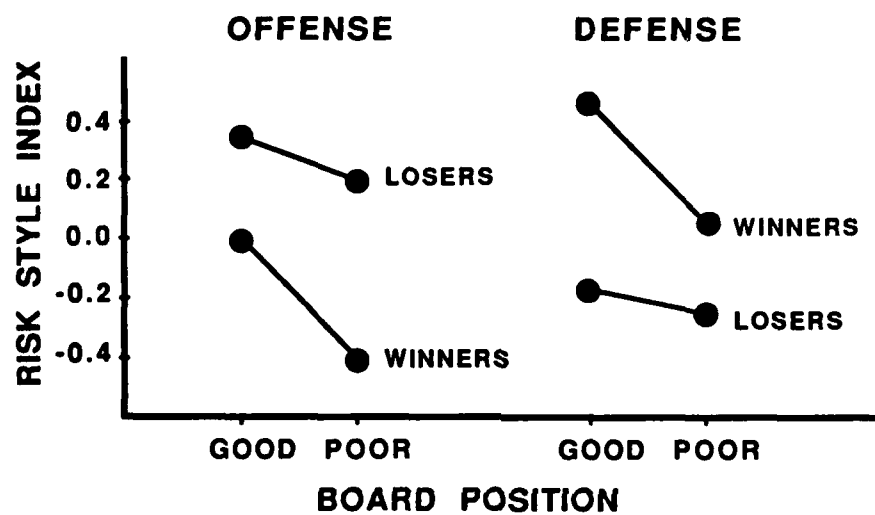
Figure 4:   Experiment 1

Figure 5: Experiment 1

Figure 6: Experiment 1

Figure 7: Experiment 1

Figure 8: Experiment 2

Figure 9: Experiment 2
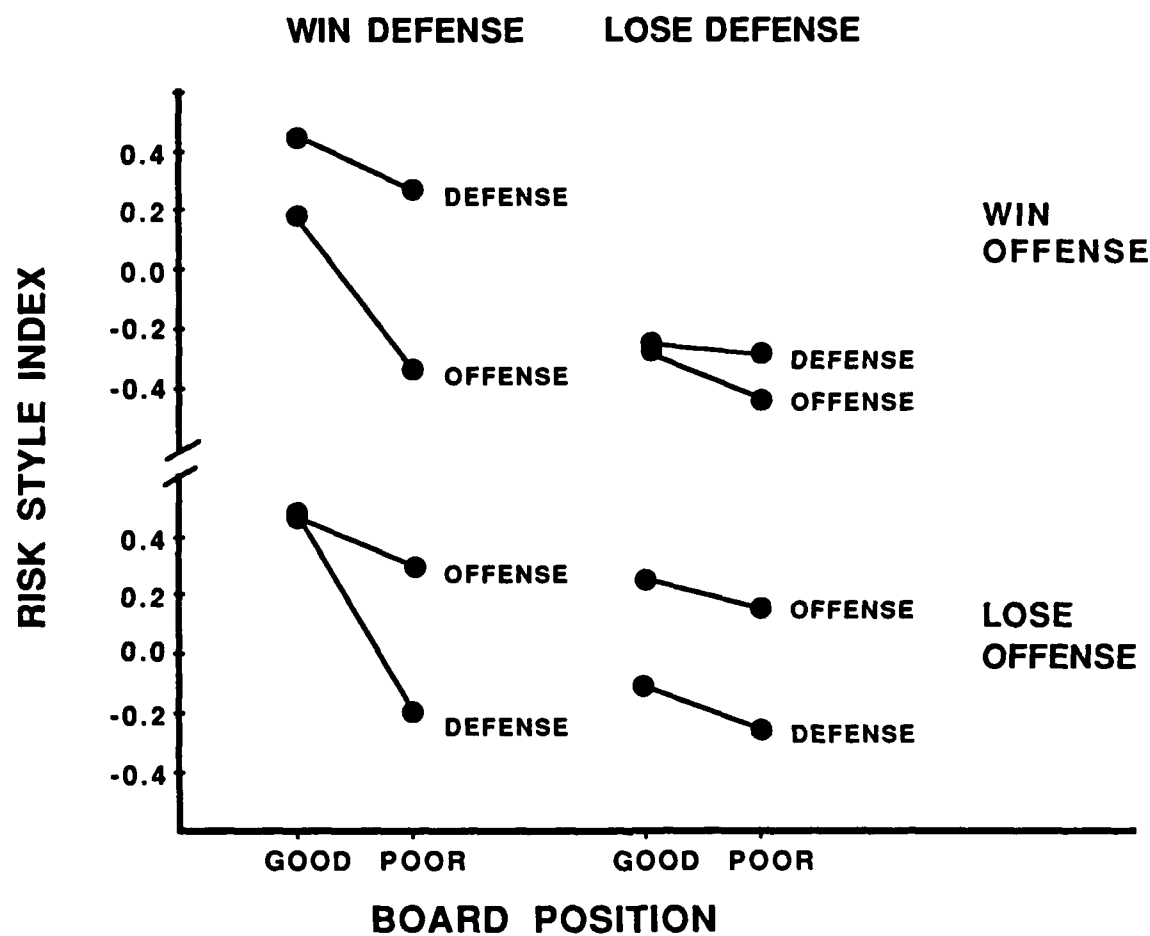
Figure 10: Experiment 2
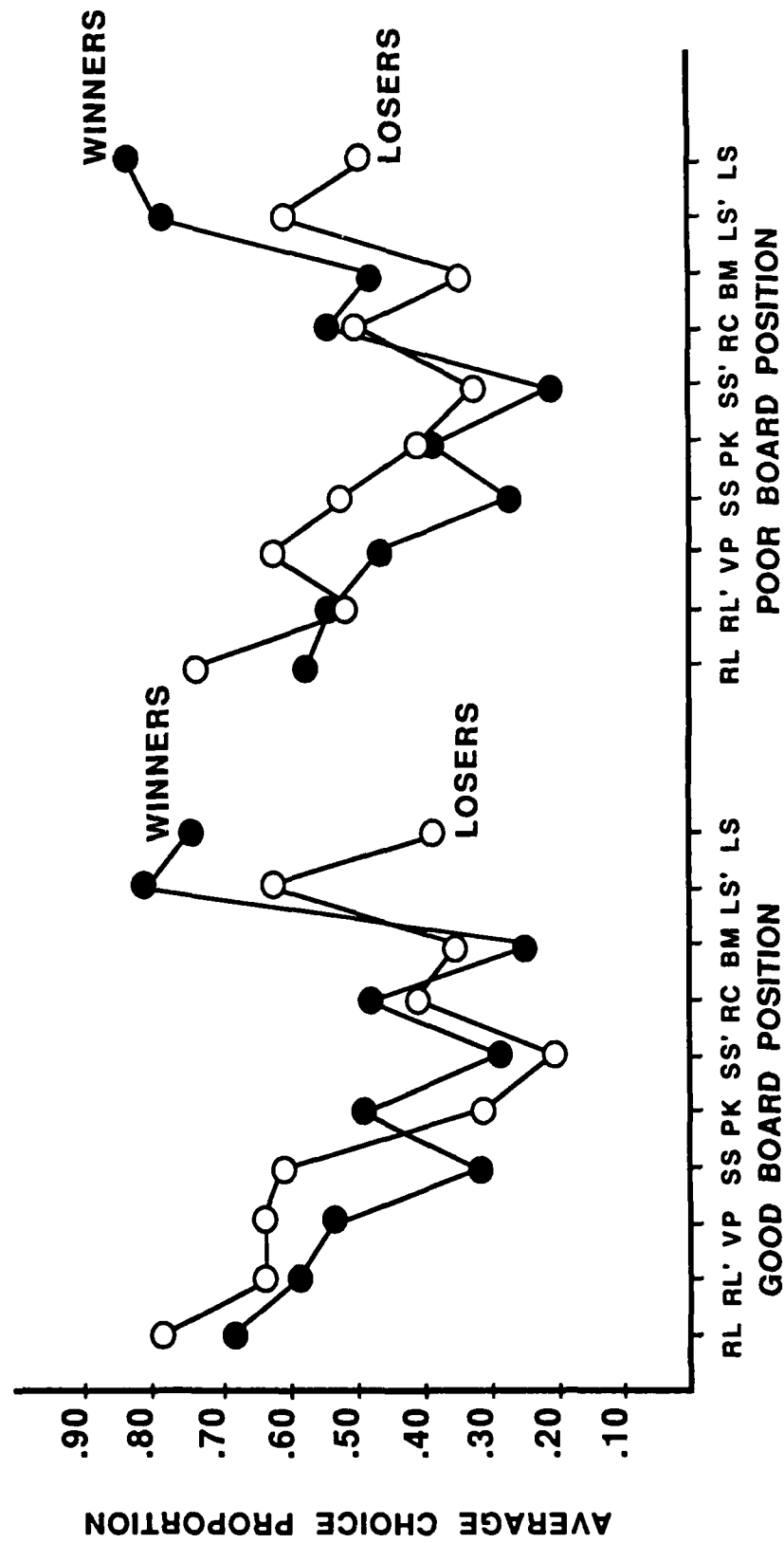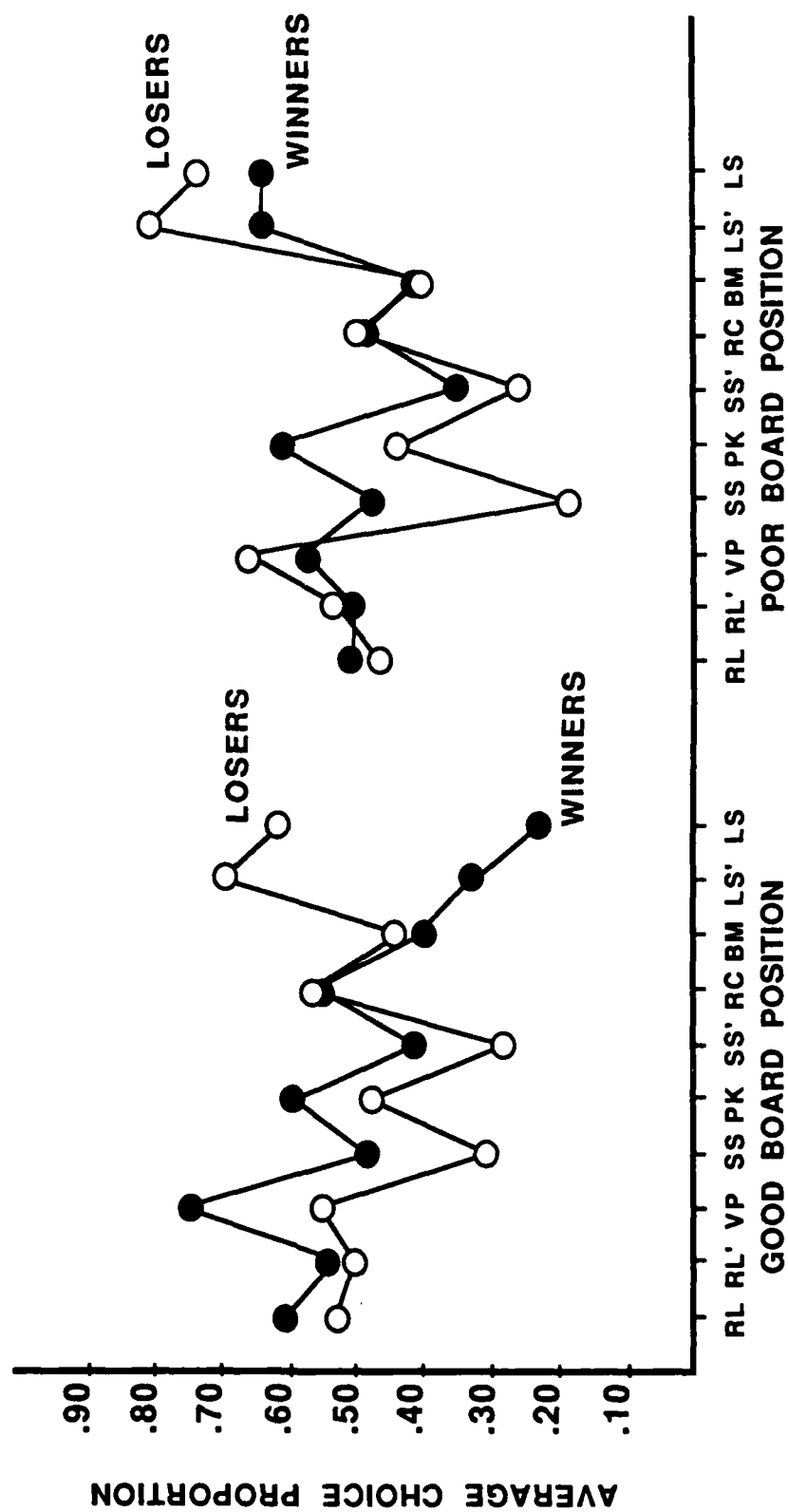
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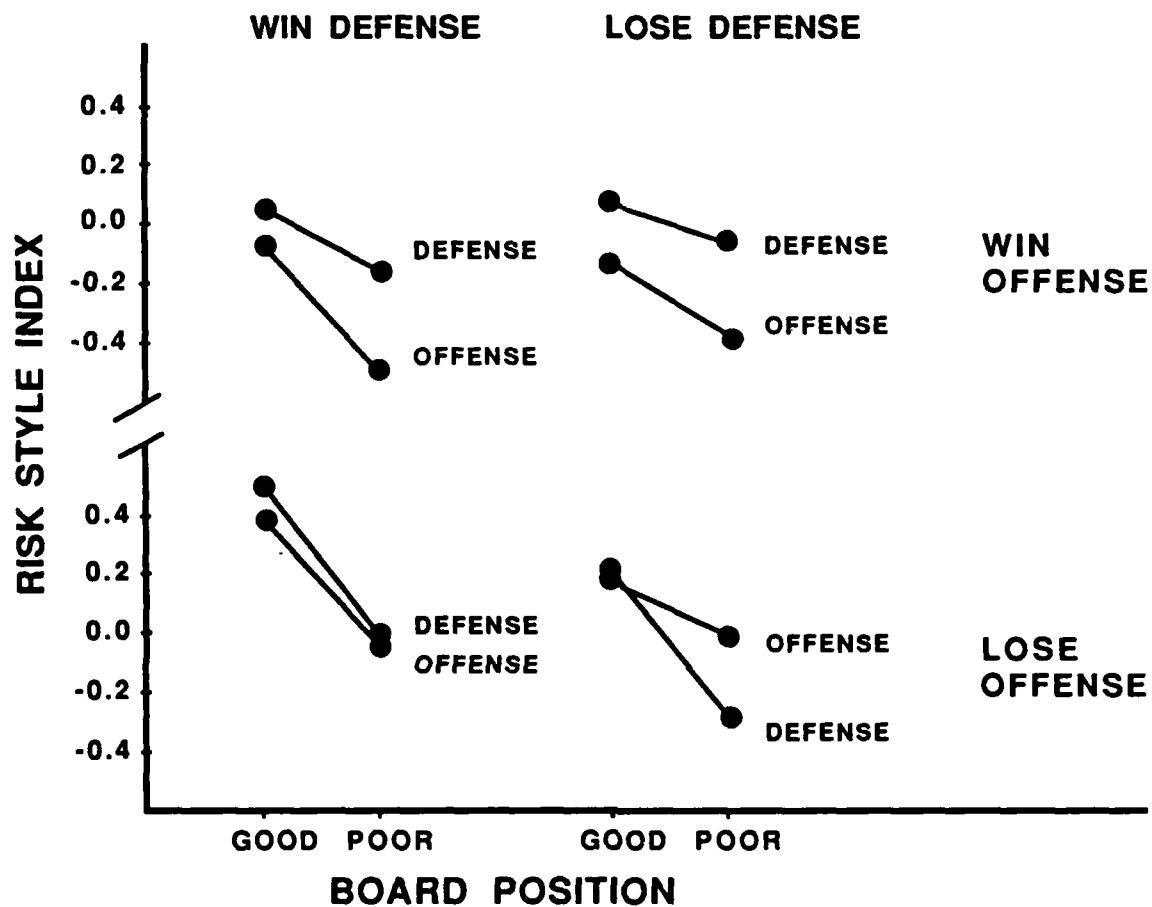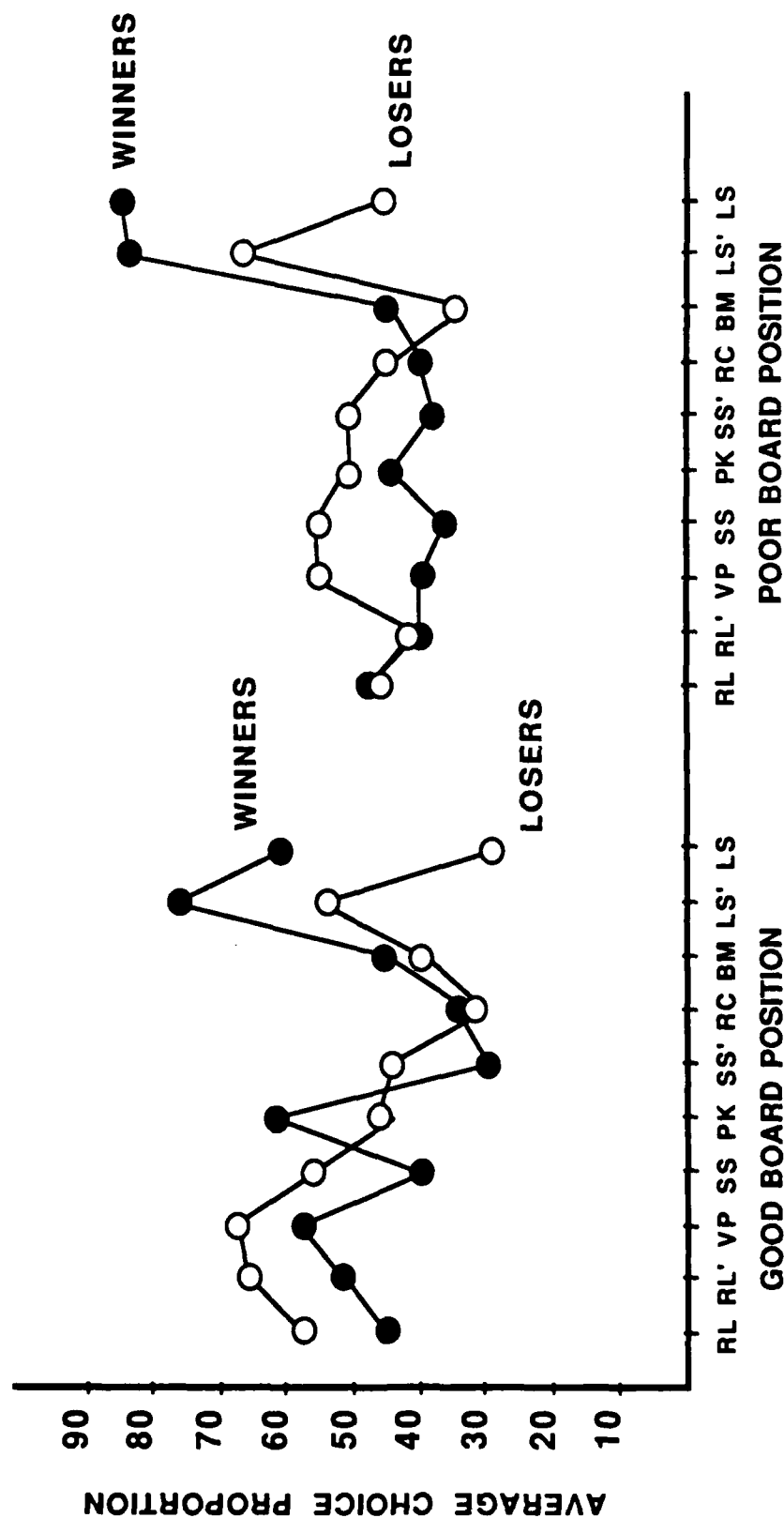
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LOSERS

WINNERS

GOOD BOARD POSITION

POOR BOARD POSITION

RL RL' VP SS PK SS' RC BM LS' LS

RL RL' VP SS PK SS' RC BM LS' LS

AVERAGE CHOICE PROPORTION

90 80 70 60 50 40 30 20 10

Figure 11: Experiment 2
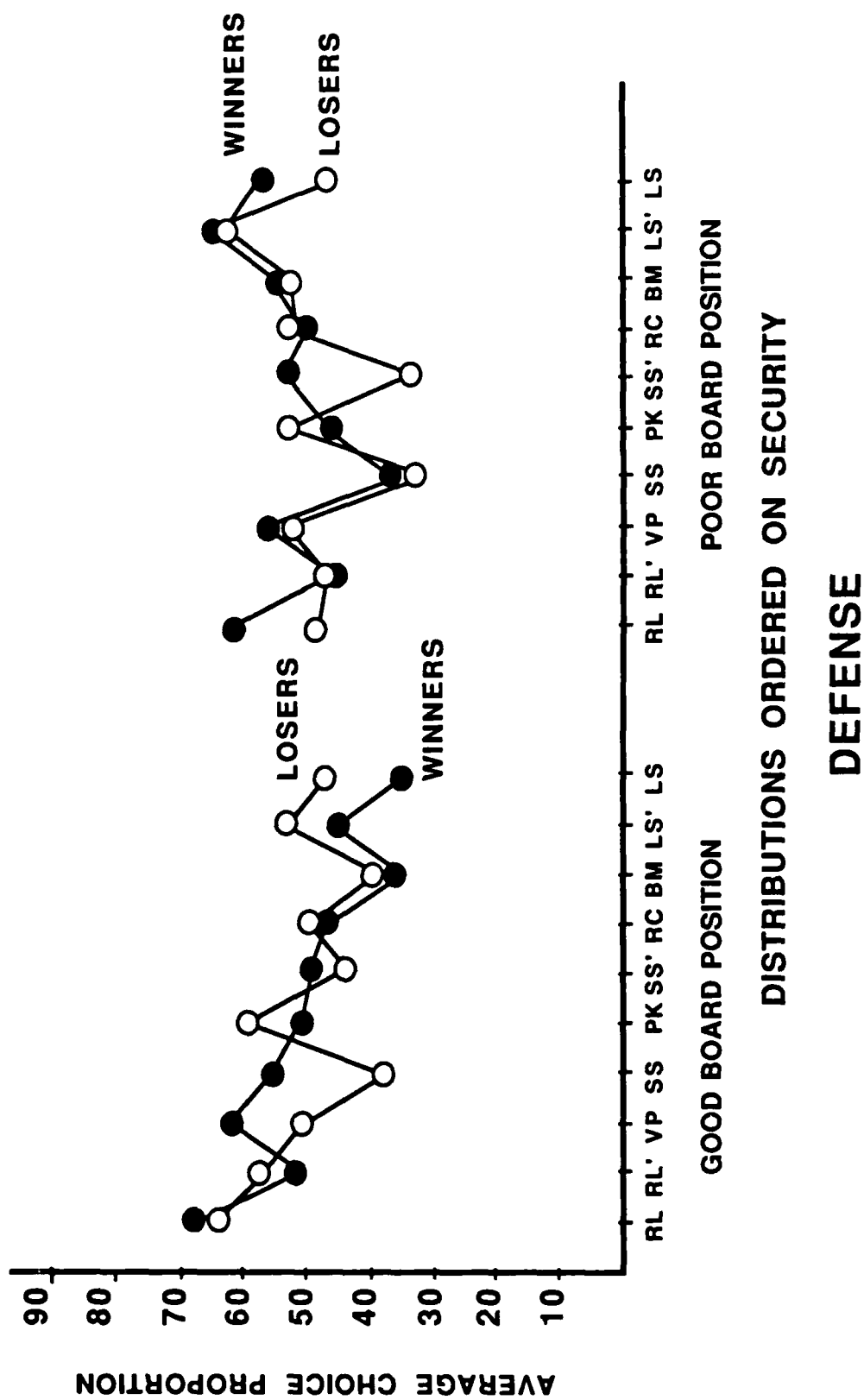
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